

Response to the PCT Written Opinion

1) The following opinions (1) to (3) were expressed in the Response dated December 28, 2004 issued by the PCT International Searching Authority.

(1) Claims 1 to 6 do not possess novelty. As the reason for this, the Examiner is stating that Documents 1 and 2 describe zinc oxide powder in which the concentration of various impurities is 1ppb or less with high purity zinc metal having a purity of 99.99999% as the starting material, and Document 3 describes zinc oxide powder having a purity of 99.999% with high purity zinc having a purity of 99.999% as the starting material.

(2) Claims 1, 3 and 6 lack novelty since Document 4 describes zinc oxide particles in which the concentration of impurities is 70ppm or less.

(3) Claims 7 to 9 possess novelty and inventive step.

2) The Cited Documents are the following Documents 1 to 4.

Document 1: JP2003-192346

Document 2: JP2001-039713

Document 3: Toshihiko Matsumoto et al., Electrical Properties of High Purity Zinc Oxide Sintered Compact, Nihon University, Department of Literature and Science, Natural Science Research Center, Research Bulletin, 1981, No.16, p.5.21-5.26

Document 4: JP03-050119

3) The amendments are foremost explained.

The requirement of "wherein the total content of gas components C, Cl and S is less than 100wtppm" of previous claim 3 (before amendment) has been newly introduced in all new claims 1 to 11. Further, the inappropriate descriptions regarding previous claims 1 to 6 (before amendments) have been corrected as shown in new claims 1 to 11; specifically, by separating "high purity zinc oxide powder", "sputtering target" and "high purity zinc oxide thin film". Thus, since the claim numbers were moved down, the subsequent claims are indicated as being newly added.

The "manufacturing method of high purity zinc oxide powder" described in previous claims 7 to 9 (before amendment) are now claims 12 to 14 since claims were added and the claim numbers were moved down, but the subject matter thereof is substantially the same.

For the ease of comparison with the Cited Documents, independent claims 1, 4 and 8 are indicated once again below. Incidentally, the indication of claim 12 in which the Examiner stated possesses inventive step is omitted.

[1] High purity zinc oxide powder wherein the impurity content excluding gas components of N, C, Cl, S and P is less than 10wtppm, and the total content of gas components C, Cl and S is less than 100wtppm.

[4] High purity zinc oxide sputtering target wherein the impurity content excluding gas components of N, C, Cl, S and P is less than 10wtppm, and the total content of gas components C, Cl and S is less than 100wtppm.

[8] High purity zinc oxide thin film wherein the impurity content excluding gas components of N, C, Cl, S and P is less than 10wtppm, and the total content of gas components C, Cl and S is less than 100wtppm.

4) Next, the present invention and the Cited Documents 1 to 4 are compared.

As indicated by the Examiner, Documents 1 and 2 describe zinc oxide powder in which the concentration of various impurities is 1ppb or less with high purity zinc metal having a purity of 99.99999% as the starting material, Document 3 describes zinc oxide powder having a purity of 99.999% with high purity zinc having a purity of 99.999% as the starting material, and Document 4 describes zinc oxide particles in which the concentration of impurities is 70ppm or less.

Here, the issue is that these Documents do not provide any description regarding "wherein the total content of gas components C, Cl and S is less than 100wtppm", which is an important constituent element of the invention claimed in independent claims 1, 4 and 8. Based on this fact, it would be clearly erroneous to state that the inventions of Documents 1 to 4 and the present invention are the same, or to use such Documents 1 to 4 as grounds or reasons for rejecting the present invention.

5) Generally speaking, when indicating the purity of a high purity material, gas components such as carbon are excluded. This is because it is extremely difficult to remove gas components such as carbon, and because there is no recognition that such substances have an adverse effect.

For instance, although Cited Documents 1 and 2 described zinc oxide with zinc metal having a purity of 7N (99.99999%) as the starting material, it is impossible to obtain a material in which the gas components are 0.1ppm or less with the manufacture process at the disclosed level. This is clearly referring to purity excluding gas components.

Thus, with the zinc oxide having high purity zinc as its starting material described in Cited Documents 1 to 4, the issue of gas components such as carbon is entirely disregarded. In other words, with the technology of Cited Documents 1 to 4, carbon and other gas components are contained in high concentrations, and this signifies that such content is tolerated. If there is no recognition that gas components such as carbon will become a problem, the idea of reducing such gas components will never occur.

6) With the present invention, as described in the Description, in particular, as a sputtering target or thin film to be used in electronic components such as a semiconductor device, high purity zinc oxide powder having a purity of 99.99wt% or more is required. In particular, it is necessary that the impurity content excluding gas components of N, C, Cl, S and P is less than 10wtppm and the content of gas component of C, Cl and S is less than 100wtppm since such impurities will have an adverse effect on the characteristics of ZnO.

These gas components are problems since these respectively form carbide, chloride and sulfide. Further, as described in the Description, among the above, it is desirable to reduce especially Cl as much as possible since it increases the leakage current when the TFT is turned off. It is also desirable that S is reduced as much as possible since it deteriorates the mobility due to the scattering of impurities. Further, during sputtering for forming a thin film, C, Cl and S all cause the increase of particles that deteriorates the film characteristics.

As described above, Cited Documents 1 to 4 do not in any way describe or suggest the reduction of such gas components of C, Cl and S, why such reduction is necessary, and what kind of effect such reduction will yield. And, it is impossible for Document 1 to Document 4 to achieve similar operation and effect as the present invention claimed in claims 1, 4 and 8.

7) Accordingly, we believe that it would be erroneous to indicate that Documents 1 to 4 are the same as the present invention, or to indicate that the present invention claimed in claims 1, 4 and 8 could have been easily achieved based on Documents 1 to 4.

Further, in addition to claims 1, 4 and 8, claims 2, 3, 5, 7, 9 to 11 are all dependent claims of claims 1, 4 and 8. In other words, these dependent claims also possess novelty and inventive step as with claims 1, 4 and 8.

Incidentally, we will refrain from making any comment regarding claims 12 to 14 since the Examiner indicated that these claims possess inventive step.

As described above, it is evident that the present invention possesses patentability.